Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2, 2018					

ENG227 – Electromagnetics and Communication Technology	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

The examination has 12 questions. Questions must be answered on the answer booklet.
This examination paper must not be removed from the exam room.
Read all questions carefully.
Show all working and units.

EXAM CONDITIONS

<u>You may begin writing from the commencement of the examination session.</u> The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
Lecture Notes (Annotated Permitted) Lecture Notes (Unannotated) Lecture Textbook/s (Annotated Permitted) Lecture Textbook/s (Unannotated)	1 x 20 Page Book

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1

Consider a message with $x(t)=\cos 2\pi 1000t+(1/3)\cos 2\pi 1500t+(1/2)\cos 2\pi 1800t$ and $A_c=10$. Sketch the positive output spectrum if the modulation were 100% modulated DSB with carrier, DSB without carrier and USSB.

(6 Marks)

Question 2

The frequency deviation of a 5 MHz frequency modulated signal is 4 kHz. With this input signal, how can a frequency modulated output with a signal frequency of 50 MHz and a frequency deviation of 24 kHz be obtained?

(4 Marks)

Question 3

Obtain the energy spectral density, autocorrelation, and average signal power for an energy signal $\upsilon(t)=A_1\cos(\omega_0 t+\phi_1)$.

(6 Marks)

Question 4

Discuss an advantage and a disadvantage of using double sideband without carrier modulation compared to double sideband with carrier modulation in an analogue communication system.

(3 Marks)

Question 5

The audio portion of television transmitter is an indirect FM system having W = 10 kHz, D = 2.5, and f_c = 4.5 MHz. Devise a block diagram of this system with $\phi_\Delta/2\pi T$ < 20 Hz and f_c = 200 kHz. Use the shortest possible multiplier chain consisting of frequency triplers and doublers.

(3 Marks)

Question 6

Discuss the transmission of light through the graded index optical fibre. How can this fibre be used to avoid the multimode dispersion?

(3 Marks)

Question 7

A single mode fibre has a core diameter of 8 μm and a refractive index of 1.46. The index difference is 0.003.

(a) What is the single mode cut-off wavelength of the fibre?

(b) Calculate the numerical aperture of the fibre.

(4 Marks)

Question 8

How does dispersion limit the performance of a fibre optic system?

(2 Marks)

Question 9

(a) Discuss the mechanism for semiconductor laser to generate light.

(b) A semiconductor laser for operation around 1.3 μm has a cavity length of 300 μm and an index of refraction of 3.2. The mirror reflectivities are 0.9 and the loss coefficient is 300 m^{-1}. Find the minimum gain coefficient required for lasing.

(5 Marks)

Question 10

A semiconductor laser emitting light at a wavelength of 0.9 μm has an optical cavity of length 130 μm. The refractive index of the semiconductor is n=3.5.

(a) Determine the wavelength separation between the longitudinal modes.

(b) Briefly describe how single mode operation may be obtained in a semiconductor laser.

(5 Marks)

Question 11

What are the two main laser structures? Discuss with the use of diagram on the two main laser structures.

(4 Marks)

Question 12

The transfer function of a Mach Zehnder intensity modulator is given by

$$P_o = \frac{t_{ff}}{2} P_{in}\left(1+\cos\left(\pi \frac{V}{V_\pi}\right)\right)$$

(a) If the switching voltage V_π is 4 V, what is the bias voltage for the device to operate at the most linear region?
(b) A small RF signal $V_{RF}(t)=V_{RF}\sin(\omega_{RF}t)$ and a DC bias voltage V_b = 2 V are applied to the modulator. Derive the output RF signal power expression for a modulator switching voltage of V_π = 4 V.

(5 Marks)